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Light-Duty Automotive Technology and Fuel Economy Trends

1975 Through 2001

Appendixes

Advanced Technology Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

List of Appendixes

Appendix A

Database Details and Calculation Methods

Light-duty automotive technology and fuel economy trends are examined herein, as in preceding papers in this series [1-28], using the latest and most complete EPA data available. The source database was frozen in December 2000.

Through model year 1999, the fuel economy, vehicle characteristic and sales data used for this report were obtained from the most complete databases used for corporate average fuel economy standards and “gas guzzler” compliance purposes. For all practical purposes, these databases are stable and are not expected to change in the future. For model years 2000 and 2001, the fuel economy and sales data used for this report were extracted from the database used for the federal government's fuel economy public information programs: the *Fuel Economy Guide* and the MPG labels that are placed on new vehicles. The vehicle sales data for 2000 and 2001 used for this report have been adjusted, as necessary, to take into account sales data available in trade publications at the time the database was frozen.

The fuel economy data used in previous editions in this series of reports were unadjusted laboratory data, with no correction for laboratory to on-road shortfall, alternative fuels capability “credits”, or test procedure adjustment. Accordingly, the MPG values in previous reports in this series were always slightly lower than those reported by the Department of Transportation (DOT) and significantly higher than those provided in the *Fuel Economy Guide*. All fuel economy averages in this report are sales weighted harmonic averages.

Use of Adjusted MPG

In past reports in this series, the MPG values that have been used have been the laboratory-based city, highway, and combined MPG values—the same ones that are used as the basis for the fuel economy standards and the gas guzzler tax. Since the laboratory MPG values tend to overpredict the MPG achieved in actual use, adjusted MPG values are used for the Government’s fuel economy information programs the *Fuel Economy Guide* and the *Fuel Economy Labels* that are on new vehicles. The adjusted city MPG is obtained by multiplying the laboratory city MPG by 0.90, and the adjusted highway MPG is obtained by multiplying the laboratory highway MPG value by 0.78. If a combined “55/45" MPG

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* Numbers in brackets denote references listed at the end of the text.

value is calculated, the resulting MPG value is about 15 percent lower than the comparable value using the laboratory-based MPG values. It should be noted that an adjusted composite MPG value is *not* used in the Government's Fuel Economy Information Programs discussed above.

This report provides trends in adjusted MPG values in addition to the laboratory MPG values used previously. In this way, the MPG trends can be seen for those who are interested in laboratory MPG and for those interested in MPG values which can be considered to be an estimate of on-road fuel economy. In the Tables, these two MPG values are called "Laboratory MPG," "Adjusted MPG" and abbreviated "ADJ" MPG and "LAB" MPG.

Where only one MPG value is presented in this report, it is the "adjusted composite 55/45 combined MPG", i.e.,

$$MPG_{55/45} = 1 / (.55/ MPG_C + .45/MPG_H)$$

where MPG_C is .9 times the laboratory fuel economy on the EPA City Driving cycle and MPG_H is .78 times the laboratory fuel economy on the EPA Highway Driving cycle.

To facilitate comparison with data in previous reports in this series, most data tables include what the $MPG_{55/45}$ value would have been, had the laboratory fuel economy values not been adjusted downward, as well as the adjusted city, highway and combined 55/45 fuel economy values.

All vehicle weight data are based on inertia weight class (nominally curb weight plus 300 pounds). For vehicles with inertia weights up to and including the 3000-pound inertia weight class, these classes have 250-pound increments. For vehicles above the 3000-pound inertia weight class (i.e., vehicles 3500 pounds and above), 500-pound increments are used.

All interior volume data for cars built after model year 1977 are based on the metric used to classify cars for the DOE/EPA *Fuel Economy Guide*. The car interior volume data in this paper combine that of the passenger compartment and trunk/cargo space. In the *Fuel Economy Guide*, interior volume is undefined for the two-seater class; for this series of reports, all two-seater cars have been assigned an interior volume value of 50 cubic feet.

The light truck data used in this series of papers includes only vehicles classified as light trucks with gross vehicle weight ratings (GVWR) up to 8,500 pounds. Vehicles with GVWR between 8,500 and 10,000 pounds are not included in the database used for this report. Omitting these vehicles influences the overall averages for all variables studied in this paper. Currently, total sales of trucks with GVWR between 8,500 and

10,000 pounds represent only about 6 or 7% of the total sales of trucks with GVWR of 8,500 pounds or less.

To the extent that trucks with GVWR between 8,500 and 10,000 pounds have lower fuel economy than the average for the trucks reported in this paper, the average fuel economy of the 0 to 10,000 pound GVWR light-truck fleet will be about 4% lower (and the fuel consumption higher) than the values reported here.

In addition to fuel economy, some tables in this paper contain alternate measures of vehicle fuel efficiency as used in reference 17. "Ton-MPG" is defined as a vehicle's MPG multiplied by its inertia weight in tons. This metric provides an indication of a vehicle's ability to move weight (i.e., its own plus a nominal payload). Ton-MPG is a measure of powertrain/ drive-line efficiency. Just as an increase in vehicle MPG at constant weight can be considered an improvement in a vehicle's efficiency, an increase in a vehicle's weight-carrying capacity at constant MPG can also be considered an "improvement."

"Cubic-feet-MPG" for cars is defined in this paper as the product of a car's MPG and its interior volume, including trunk space. This metric associates a relative measure of a vehicle's ability to transport both passengers and their cargo. An increase in vehicle volume at constant MPG could be considered an improvement just as an increase in MPG at constant volume can be.

"Cubic-feet-ton-MPG" is defined in this paper as a combination of the two previous metrics, i.e., a car's MPG multiplied by its weight in tons and also by its interior volume. It ascribes vehicle utility to the ability to move both weight and volume.

This paper also includes an estimate of 0-to-60 MPH acceleration time, calculated from engine rated horsepower and vehicle inertia weight, from the relationship:

$$t = F\ (HP/WT)^{-f}$$

where the values used for F and f coefficients are .892 and .805 respectively for vehicles with automatic transmissions and .967 and .775 respectively for those with manual transmissions [29]. Other authors [30, 31, and 32] have evaluated the relationships between weight, horsepower, and 0-to-60 acceleration time and have calculated and published slightly different values for the F and f coefficients.

The 0-to-60 estimate used in this paper is intended to provide a quantitative time "index" of vehicle performance capability. It is the authors' engineering judgment that, given the differences in test methods for measuring 0-to-60 time and given the fact that the weight is based on inertia weight, use of these

other published values for the F and f coefficients would not result in a significantly different 0-to-60 relative performance estimate. The results of a similar calculation of estimated “top speed” are also included in some tables.

Grouping all vehicles into classes and then constructing time trends of parameters of interest, like MPG, can provide interesting and useful results. These results, however, are a strong function of the class definitions. Classes based on other definitions than those used in this report are possible, and results from these other classifications may also be useful

For cars, vehicle classification as to vehicle type, size class, and manufacturer/origin generally follows fuel economy label, *Fuel Economy Guide*, and fuel economy standards protocols; exceptions are listed in Appendix B. In many of the passenger car tables, large sedans and wagons are aggregated as "Large," midsize sedans and wagons are aggregated as "Midsize," and "Small" includes all other cars. In some of the car tables, an alternative classification system is used, namely: Large Cars, Large Wagons, Midsize Cars, Midsize Wagons, Small Cars, and Small Wagons with the EPA “Two-Seater, Mini-Compact, Subcompact, and Compact” car classes combined into the “Small Car” class.

The truck classification scheme used for all model years in this paper is slightly different from that used prior to 1999 in this series, because pickups, vans, and sports utility vehicles (SUVs) are sometimes each subdivided as "Small," “Midsize,” and "Large." These truck size classifications are based primarily on published wheelbase data according to the following criteria:

	Pickup	Van	SUV
Small	Less than 105"	Less than 109"	Less than 100"
Midsize	105" to 115"	109" to 124"	100" to 110"
Large	More than 115"	More than 124"	More than 110"

This classification scheme is similar to that used in many trade and consumer publications. For those vehicle nameplates with a variety of wheelbases, the size classification was determined by considering only the smallest wheelbase produced.

Appendix C lists the model year 2001 nameplates by size class and their sales-weighted average 55/45 MPG as of the data freeze date.

Appendix D contains information about how the factors used in the 55/45 MPG calculation relate to the fraction of driving that is “urban” and also contains data on how the urban or “city fraction” of travel has changed over time.

Appendix A

Appendix E lists and describes the most, and least, fuel efficient vehicles for model years 1975 to 2001. This appendix also includes the sales weighted fuel economy distribution data.

Appendixes F through I contain a series of tables in which the fleet is grouped into classes and stratified based on vehicle type, vehicle type and size, EPA car class, and inertia weight class, respectively.

Appendixes J through M contain a series of tables in which the fleet is grouped into classes and stratified based on drive, transmission type and number of gears, cylinder count, and by the number of engine valves per cylinder, respectively.

Appendix N contains tables that provide detailed data related to the Fuel Economy Improvement Potential section of this report.